

TECHNICAL OVERVIEW

ESIG2000

**Setting the Standard
for Low Cost
Image Generation**

EVANS & SUTHERLAND

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ESIG-2000

SETTING THE STANDARD FOR LOW COST IMAGE GENERATION

Evans & Sutherland introduces the ESIG®-2000, the new standard in low cost image generation systems. The ESIG-2000 has capabilities that were previously available only in high-end visual systems. They're now incorporated in a compact design ideal for low cost applications.

Meeting a wide variety of needs

- Networked simulation systems
- Combined arms tactical training
- Basic flight simulation
- Cockpit procedures training
- Part task training
- Conduct-of-fire training
- Infrared imaging sensor systems training
- Part task engineering simulation
- Air traffic control tower operator training
- On-board, strap-on, and embedded training systems
- Ship bridge handling simulation
- Periscope simulation
- Basic and high performance driving simulation

A New Approach To Low Cost Simulation

The ESIG-2000 was developed to meet the needs of the rapidly growing low end simulation market. This market has been characterized by specialized programs with restricted budgets that dictate the use of basic image generation systems driving unsophisticated displays. Additionally, these programs frequently require relatively large production quantities.

Up to now, image generation systems in this low end market have been based on limited workstation technology. This low end technology precludes the ability to provide sophisticated scene management, apply and control texture, and achieve adequate coverage with high scene quality. Attempts have been made to expand workstation technology into image generation systems, resulting in the user needing to create much of the programming and special applications at significant extra cost.

Evans & Sutherland has taken a different approach to solving the low cost image generator problem. Starting with the state-of-the-art computer image generation technology, E&S has streamlined and repackaged the powerful technology incorporated in the world's finest image generation systems into a compact, configurable system. The ESIG-2000 provides the user a design-to-cost flexibility never before attainable.

Key Features of the ESIG-2000

- True image generator – not a workstation
- High image quality with advanced texture
- Versatile in configuration and output
- Compact size

Strong Family Heritage

Evans & Sutherland, a pioneer in the computer graphics industry and the world leader in visual simulation technology, understands the simulation and training business. E&S visual systems are in operation around the world—from the best selling Novoview and SPX lines in civil airline simulation to the renowned CT series for military and engineering applications. The ESIG-2000 is the newest member of the ESIG® family and combines the essential features of ESIG-3000 architecture into a compact, modular design. The high performance ESIG-3000 was the culmination of over two decades of experience in research, development, and production of image generation systems. In creating the ESIG-3000 architecture, E&S designers looked to the best in established systems—including Novoview, SPX, and CT series systems.

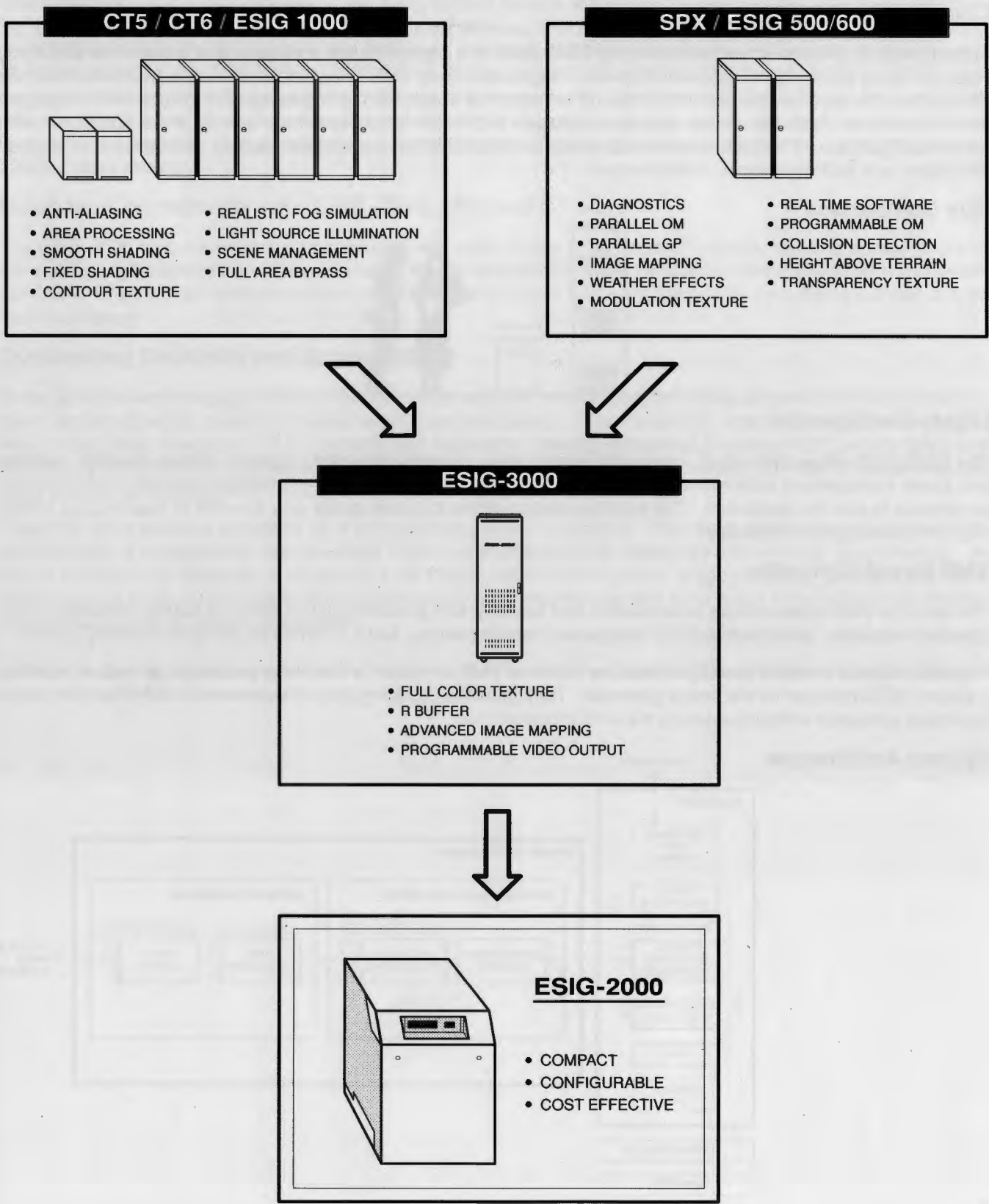
The ESIG-2000's exceptional reliability, maintainability, and supportability are derived from the Novoview and SPX family of image generators—the leading choice of the demanding civil airline market. This includes the SPX highly parallel architecture and configurable real-time software that provides the flexibility to support a variety of training applications.

From the CT series systems, the ESIG-2000 has incorporated a proven area-based processing architecture that provides the unparalleled pixel rendering efficiency, high image quality, database management algorithms, and shading techniques that characterize Evans & Sutherland image generation systems.

Drawing from technology introduced with the ESIG-3000, the ESIG-2000 incorporates powerful hybrid range buffering, full color texture, advanced Application Specific Integrated Circuits (ASIC), and a modular, expandable design. These allow for the increased processing power and the compact packaging necessary to satisfy the cost-conscious low-end market. ESIG-2000 users also benefit from the high logistic commonality between the ESIG-2000 and 3000 systems.

The result is an image generation system that provides optimized and cost effective, simulation and training solutions for a wide range of applications.

Heritage

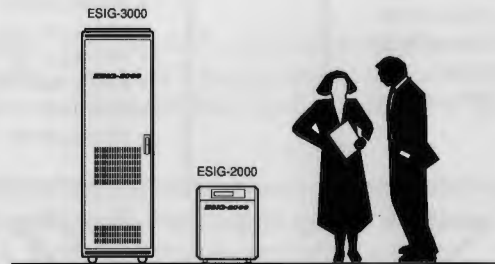


Flexible System Design

Compact Package

Fundamental to the cost-effectiveness of the ESIG-2000 is a highly efficient electronic and mechanical packaging design. Taking advantage of application specific integrated circuitry (ASIC) developed by Evans & Sutherland for the ESIG-3000, the design of the ESIG-2000 has miniaturized the already compact packaging of the powerful image generation hardware. Available are two standard packages: a 25-inch high portable floor cabinet, and a single unit, rack-mount configuration. The rack mounted configuration is suitable for applications such as embedded and strap-on simulators, and field deployable, mobile trainers.

Size Comparison



Highly Configurable

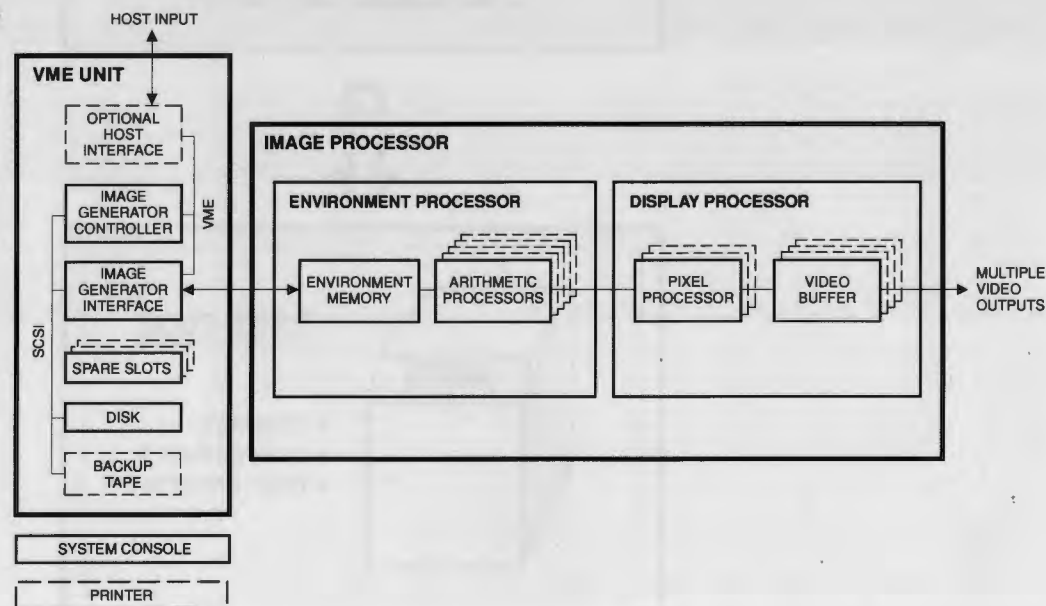
The ESIG-2000 allows tailoring of update and refresh rates, polygon processing capacity, texture capacity, overload and scene management techniques, resolution and video output format, database storage capacity, and supporting peripherals to suit the application. The resulting design allows the user to pay only for what is required, but retains plug-compatible growth capability.

VME Based Controller

The use of a VME chassis offers expandability and flexibility with a commercial off-the-shelf 68030 processor board, standard interfaces, cost effective SCSI storage and backup devices, and a commercial real time operating system.

A special purpose interface board connects the front-end VME computer to the image processor, as well as providing a second SCSI disk port for the image generator. During database paging, data is transferred directly from the disk to the image processor without burdening the VME processor bus.

System Architecture



Output Video Flexibility

One of the most useful characteristics of the ESIG-2000 is the use of fully programmable video buffers to support the use of cost effective, commercial-off-the-shelf display devices, in addition to specialized, high performance displays. The ESIG-2000 contains a programmable pixel clock generator and timing controller which enable virtually any scan standard to be supported. Synchronization pulses can be supplied as horizontal and vertical pulses, a single composite synchronization, or sync on green. The system contains a full video frame buffer with 10 bits each of red, green, and blue video. The inherent image stability offered by non-interlaced output is also available as an optional feature for this low cost image generation system. Genlock circuitry allows the system to be synchronized to an external video source.

Database Commonality with ESIG-3000, SPX and CT

The ESIG-2000 features database commonality with other Evans & Sutherland products, allowing access to one of the world's largest libraries of existing computer image generation models. In addition, the ESIG-2000 is compatible with USAF Project 2851 database structures, allowing utilization of and interchange with the growing number of models in that library.

Outstanding Reliability and Supportability

Evans & Sutherland image generators utilize carefully selected, commercially available components offering the maximum degree of safety, reliability, maintainability, and availability. The ESIG-2000 Image Generator makes use of Very Large Scale Integration (VLSI) circuitry and Application Specific Integrated Circuitry (ASIC) which result in a compact system with high performance and reliability, and at a low cost. The reduced number of cards and card types and the commonality with the ESIG-3000 further simplifies maintainability.

The ESIG-2000 warranty is backed by a long standing, proven reputation. The maintenance program for the ESIG-2000 provides a cost-effective, low-downtime method of addressing both preventive and remedial maintenance. An off-line maintenance capability is provided by the VMEU self-confidence tests, image processor diagnostics and test patterns to aid in the rapid isolation and replacement of faulty modules as well as to assist in the adjustment or alignment of various visual system components.

Performance - Tailored To Meet Training Requirements

Image Generation Functionality is Built-In

The ESIG-2000 was designed specifically for image generation rather than as a general purpose graphics workstation. Therefore, the user is not required to develop or purchase expensive specialized software to produce imagery. With the ESIG-2000, features like real time system control of level of detail management, weather and special effects, sensor simulation, collision detection, height above terrain, laser ranging, as well as other features essential to effective training are provided in a complete, integrated package. Database compatibility is ensured because E&S develops both the image generation hardware and the database modeling system. With the ESIG-2000, image generation for visual simulation is standard, not a software option.

High Image Quality/Advanced Scene Management

Evans and Sutherland has historically been known for high image quality and outstanding scene content management. The ESIG-2000 utilizes the imaging algorithms developed for the ESIG-3000 to provide the same high scene density and image quality which has come to characterize Evans & Sutherland image generators. This includes: powerful sub-pixel anti-aliasing, temporal anti-aliasing, true range dependent fog effects, texture clamping, gamma correction, fixed and smooth shading, transparency, luminous polygons, high positional accuracies, and many others.

Critical to the ability to fully utilize specified scene content capacities is an effective scene management scheme. The ESIG-2000 employs the powerful scene management techniques developed for the CT and SPX series image generators, including hierarchical database structures which provide efficient paging of database elements from disk; rapid culling of database entities not within the instantaneous field of view; and multiple levels of detail (with transitions smoothly blended) of terrain and features. The ESIG-2000 has further improved scene content management by incorporating new techniques pioneered in the ESIG-3000, such as the unique approaches allowing control of large numbers of moving models, and the hybrid R-buffer prioritization of scene elements.

Advanced Texture Capability

The ESIG-2000 makes use of the robust texturing capabilities found in the ESIG-3000 to provide crisp, stable texture for essential detail and realism on any surface in the scene regardless of altitude or viewing distance. Full color, contour, and photographic texture provide a level of realism unique in the low cost market. The use of up to 4 independently scaled texture maps per polygon allows benefits of dynamic range support and a continuous emergence of texture level of detail. High resolution texture maps can range from 512 by 512 texels to as small as 64 by 64 texels. Texture capacities are configurable from 1 to 4 million texels on-line RAM storage.

Multiple Channel Configurations Through Sub-Channeling and Viewports

A single ESIG-2000 provides the capability to drive multiple displays with offset viewpoints through the use of sub-channeling and viewports. Each video buffer may be used to provide a single channel of high resolution imagery or may be subdivided into multiple, lower resolution channels. Up to 4 video buffers can be used to provide multiple high resolution channels. The integrated sub-channeling capability of the ESIG-2000 gives this system the cost advantage over approaches using multiple copies of workstations.

Realistic Sensor Simulation

Evans and Sutherland is sensitive to the dynamic progress of sensor simulation. The ESIG-2000 allows exceptionally high fidelity simulation of sensor imagery, including LLTV, FLIR, and NVG. The ESIG-2000 introduces built-in hardware support for such special sensor effects as full range gain and level adjust, AC coupling effects, automatic gain control and noise. The ability to support multiple display interfaces along with the computational power of a single channel processor which may be shared between two or more video outputs allow for cost effective use of the machine for dual roles such as out the window combined with sensor simulation. Slewable fields of view with image stability down to less than a degree provide the high magnifications used in many of these devices. Data base models contain material code information as well as visual color information. Multiple on-line tables allow viewports to be switched from visual to sensor simulation and provide for various diurnal and seasonal changes.

Hybrid R-Buffer Architecture

For many years, the predominant method for determining visual priority for occultation was the the cellular-priority technique introduced with the E&S CT5. This method provided excellent results for most simulation requirements. However, complex multi-vehicle simulation requirements demand new approaches which allow free movement of dynamic models in the data base. The ESIG-2000 utilizes a hybrid R-buffer/cellular-priority approach to resolving occultation in the visual scene. This hybrid R-buffer approach, mixing R-buffer occultation for moving models and fixed-priority relationships for stationary scene elements, provides rendering efficiencies unmatched by Z-buffer-only architectures. Processing resources saved through this hybrid approach are used to render scenes of higher depth complexity than would be possible otherwise.

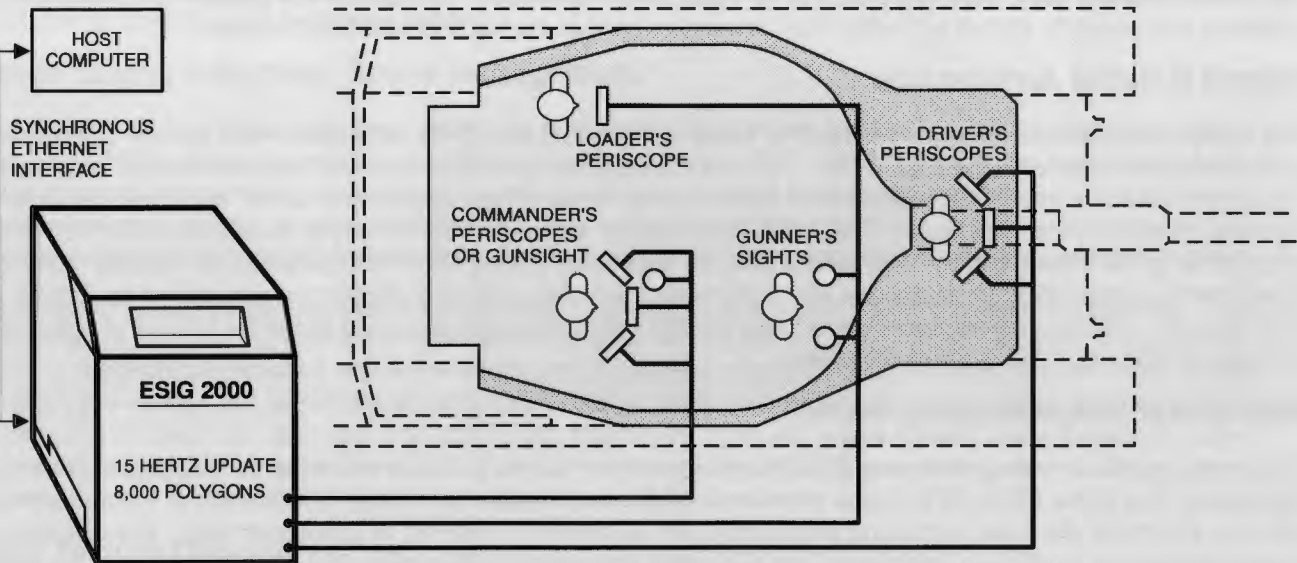
Non-Linear Image Mapping (NLIM)

A powerful non-linear image mapping (NLIM) technique which allows accurate correction for image non-linearities is an integral part of the ESIG-2000 image generator. NLIM was considered during initial design of the machine in an effort to effectively eliminate distracting anomalies such as popping, cracking, or scene overload. The distortion correction algorithms have been engineered into dedicated processing hardware so that its application has no adverse effects on polygon or pixel capacities. The image mapping solution takes place early in the computational path, preserving image resolution and quality, and providing for fields of view larger than 180 degrees. This robust NLIM capability is unmatched by any low cost image generator on the market today.

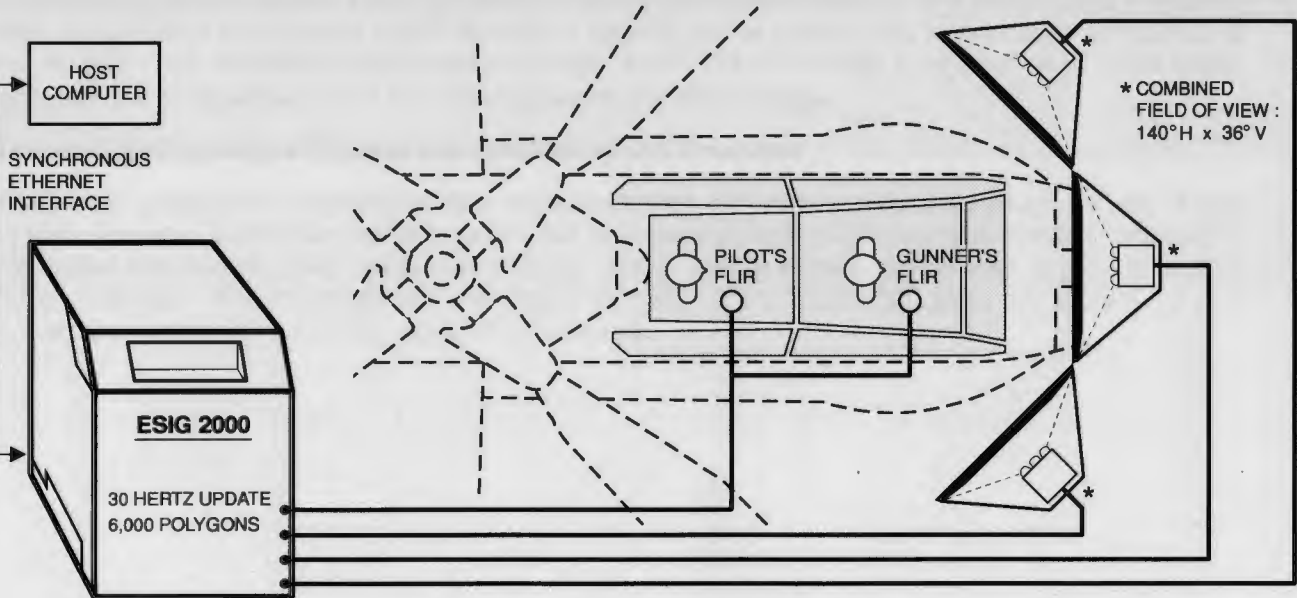
Applications - Networked Simulators

Large scale networking of simulators demands the ultimate efficiency in the cost/performance ratio from modern image generation systems. By capturing the essential algorithms of high-end image generators, the ESIG-2000 delivers the flexibility, power, and image quality required to provide necessary realism, large numbers of moving models, and multi-channel performance for effective networked training.

Networked Tactical Trainer: Tank Module Visual System



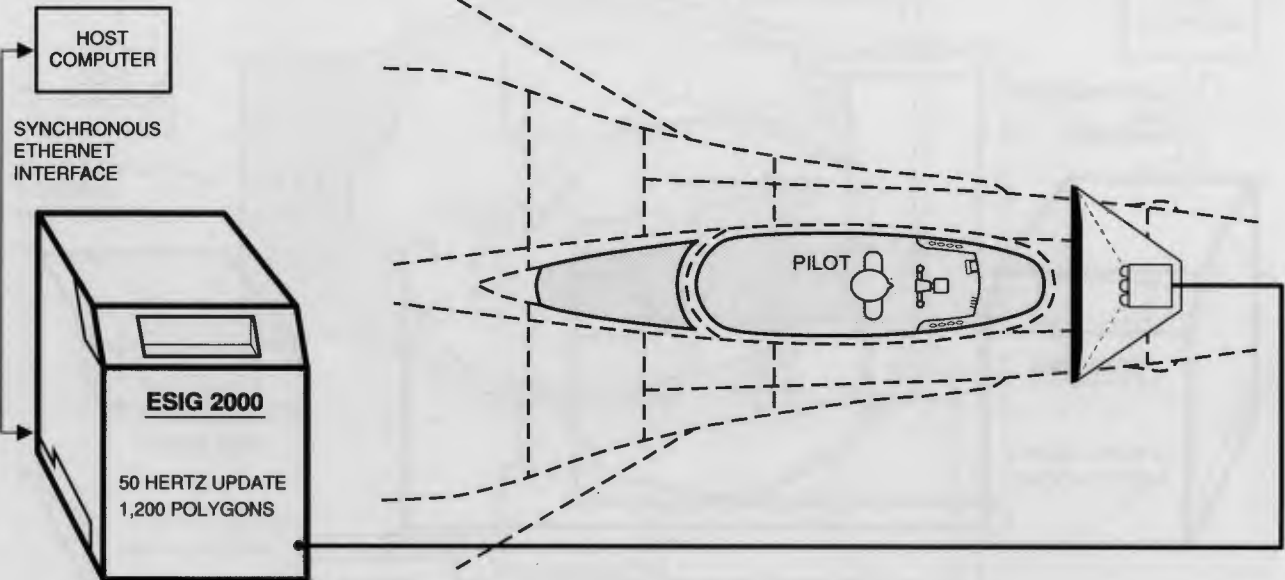
Networked Tactical Trainer: Rotary Wing Aircraft Visual System



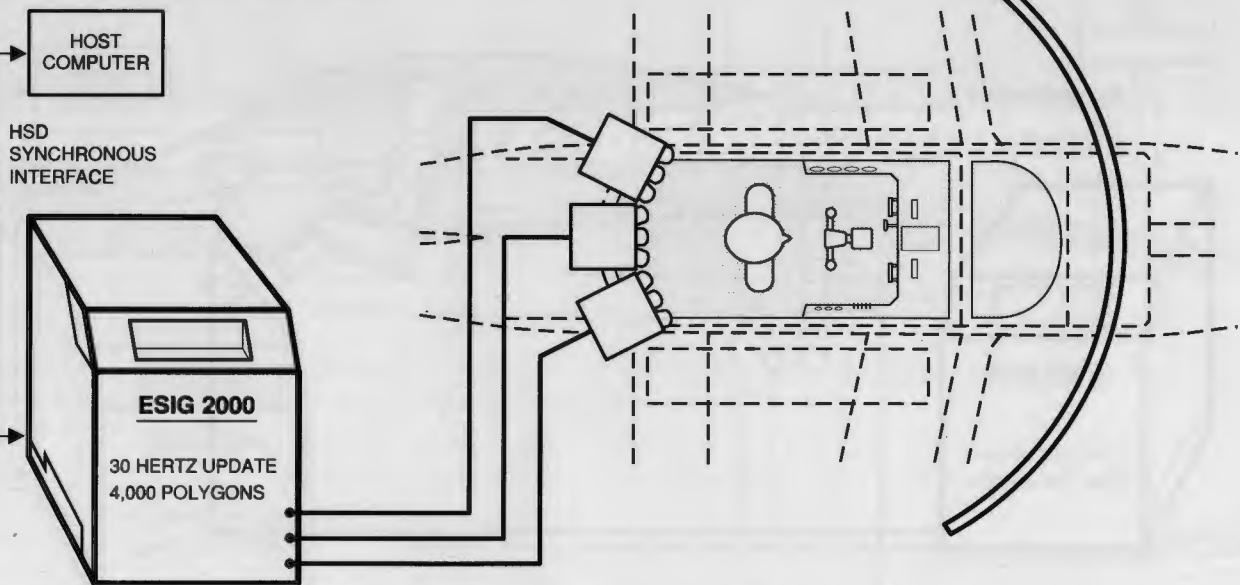
Applications - Low Cost Flight Simulators

Taking advantage of Evans & Sutherland's extensive experience in producing image generation systems for flight simulators, ESIG-2000 incorporates features essential to basic flight simulation. These include: advanced texture, realistic weather effects, accurate depiction of visual landing aids, and advanced scene management to provide necessary scene detail throughout the data base.

Cockpit Procedures Trainer / Instrument Flight Familiarization Trainer Visual System



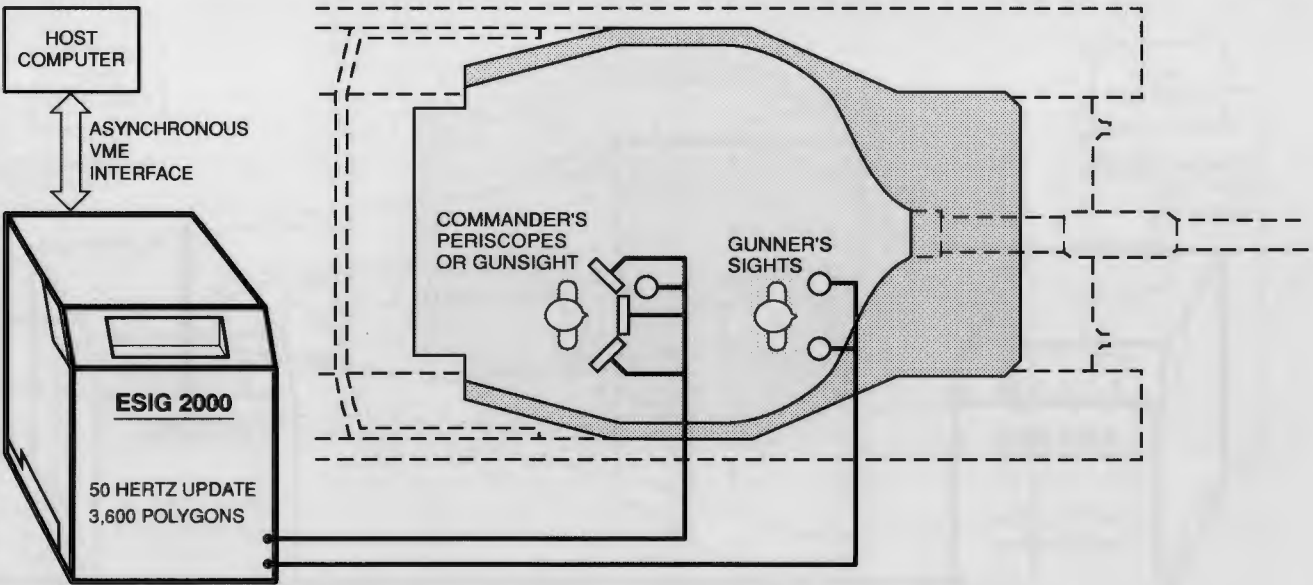
Basic Flight Simulator Visual System



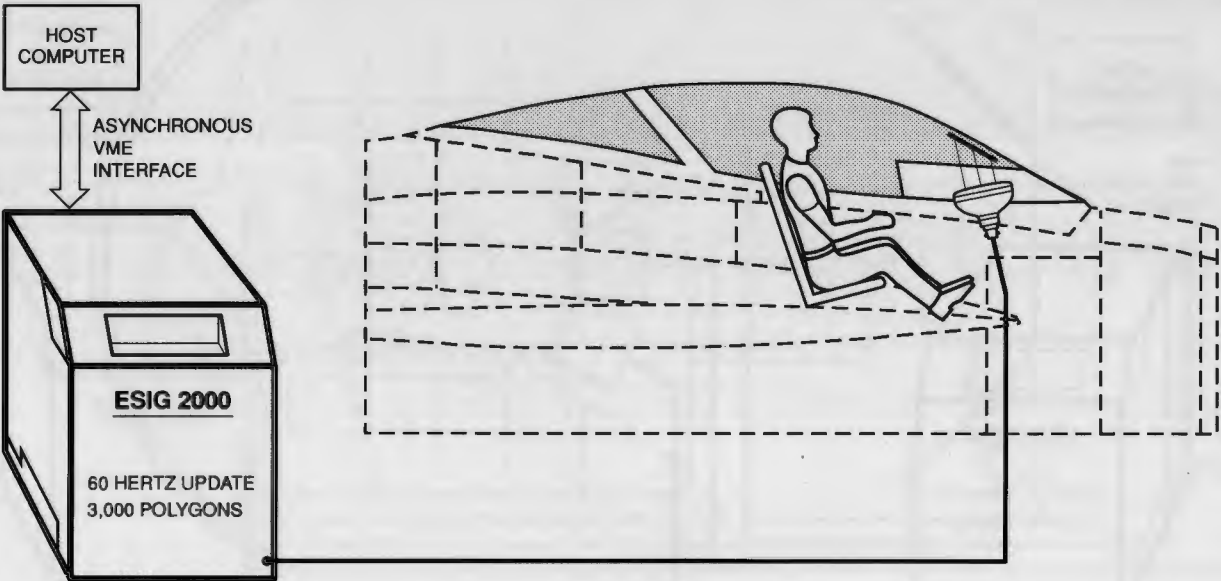
Applications - Part Task Trainers

The compact size of the ESIG-2000 allows its application to strap-on and embedded training. Its cost effectiveness makes ESIG-2000 ideal for part task engineering simulation where realistic, high update rate imagery is a must but budget constraints preclude a high-end image generation system.

Tank Precision Gunnery Trainer / Conduct-of-Fire Trainer Visual System



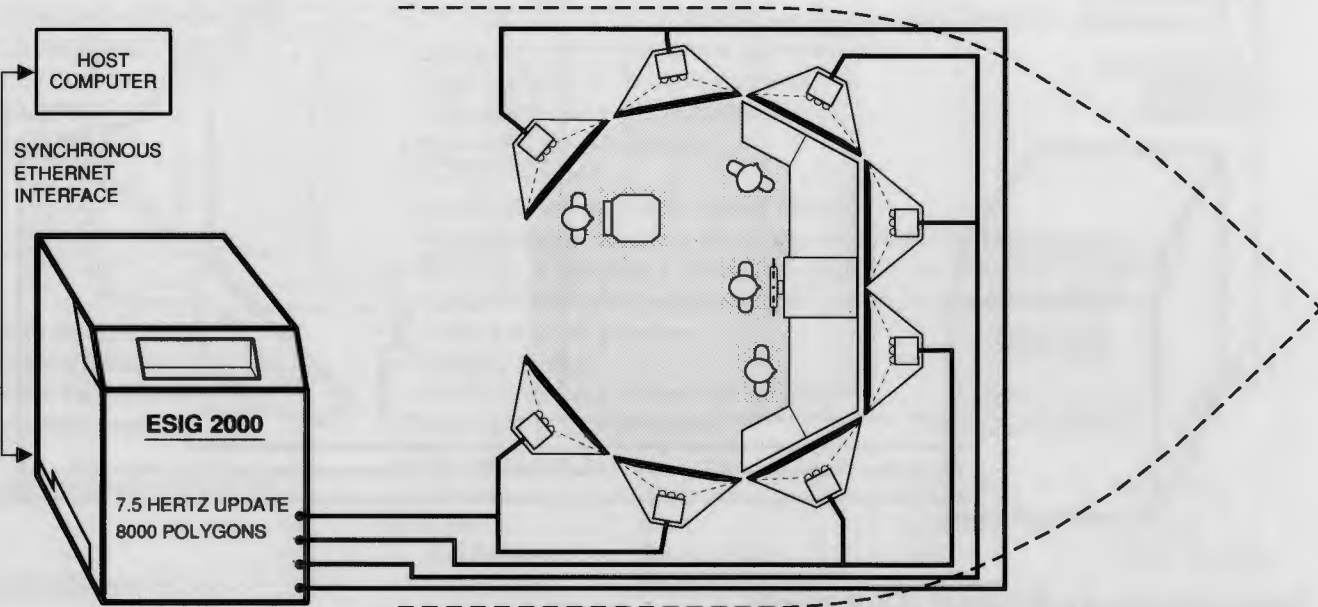
Engineering Simulator: Head-Up Display Research



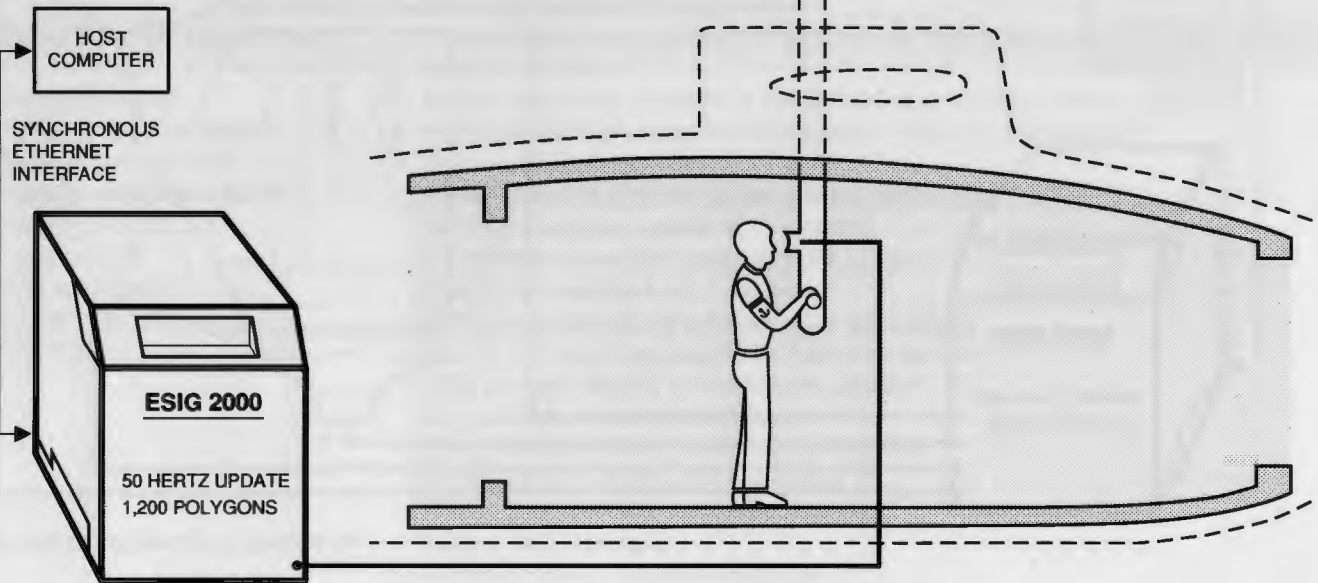
Applications - Maritime Simulators

By trading update rate for channel capacity, the ESIG-2000 provides the field of view required for ship bridge pilotage simulation at a cost comparable to the much less capable systems currently in use. Periscope simulation requires a single channel at a fast update rate to maintain scene integrity during rapid scan and high magnification. The ESIG-2000 delivers the range of performance with the scene management, image quality, and special effects that are vital to realistic maritime simulation.

Multiple Eyepoint Ship Handling Simulator Visual System



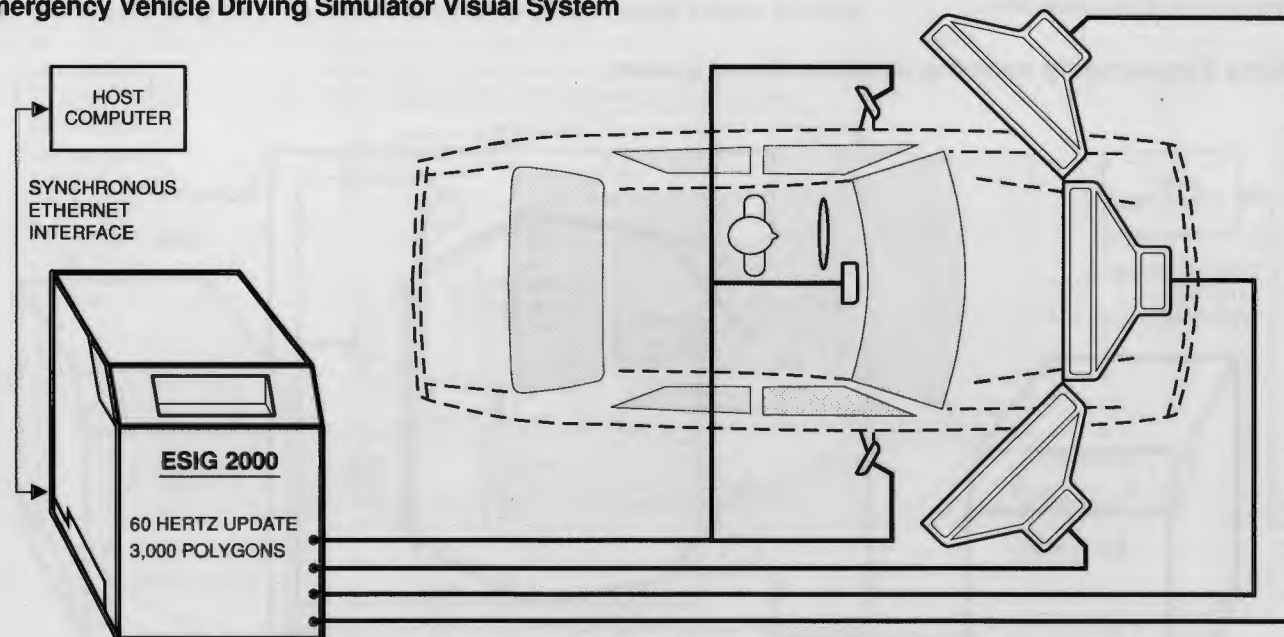
Periscope Simulator Visual System



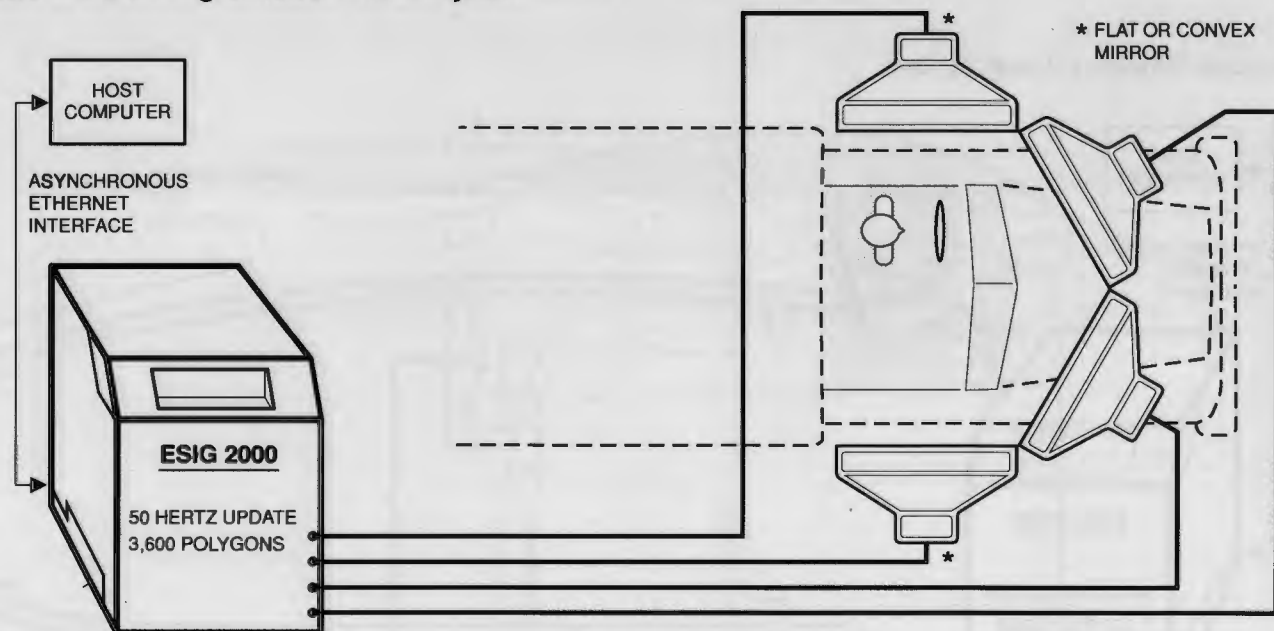
Applications - Driving Simulators

Realistic visual scene performance has previously been unavailable to the driving simulation user with a limited budget. ESIG-2000 provides the solution to this problem by delivering the speed and scene detail of today's high-end image generator, in a cost effective package.

Emergency Vehicle Driving Simulator Visual System



Basic Truck Driving Simulator Visual System



Performance Summary

MODES

VIEWPORTS

VISUAL PRIORITY

MOVING OBJECTS

ANIMATION

DATABASE MANAGEMENT

OVERLOAD TECHNIQUES

FEATURE INSTANCING

POLYGON CAPACITY

COLORS

TEXTURE

DISPLAYED LIGHTS

LIGHT STRINGS

LIGHT PATTERNS

LANDING LIGHTS

ATMOSPHERIC EFFECTS

SURFACE EFFECTS

SPECIAL EFFECTS

COLLISION DETECTION (CD)

HEIGHT ABOVE TERRAIN (HAT)

LASER RANGING

LINE-OF-SIGHT RANGING

SENSOR SIMULATION

UPDATE / REFRESH RATE

TRANSPORT DELAY

RESOLUTION

DISPLAY FORMAT

SCAN STANDARDS

DISTORTION CORRECTION

IMAGE GENERATOR COMPUTER

- DAY / DUSK / NIGHT / FLIR / NVG (Night Vision Goggles)
- Up to 8 viewports
- Range Buffer (R-Buffer) for full occultation freedom for moving objects
- Efficient fixed-relationship priority for terrain and stationary objects
- Up to 252 addressable moving objects
- Up to 256 different representations per animated object
- Multiple LOD on terrain and features
 - Fade LOD blending
 - Dynamic LOD range adjustment, frame rate update, field time extension
- Ability to provide instancing of library features
- 1000 - 12000 fully rendered polygons
- Four on-line 1024 entry color tables
- 4 texture maps per polygon
- 1-4 million texels
- Up to 256 high resolution maps (128x128)
- Programmable map dimensions, from 64x64 to 512x512
- Full Color, Photographic, Contour, Modulation and Two Color Texture
- Texture motion for animation / motion (clouds, water, smoke, etc.)
- Trade 2.5:1 with polygons
- Straight Curved
- Flashing, Rotating, Directional, Strobing
- Multiple lobe representations
- Steerable spot light
- Clouds
 - Fog/Haze
 - Ground Fog
 - Patchy Fog
- Glare
 - Scud
 - Horizon Glow
 - Lightning
- Wet Runway
 - Thunderstorm
 - Cell
 - Snowy Runway
- Flat Shading
 - Smooth Shading
 - Fixed Shading
- Transparency
 - Self Luminous Surfaces
- Dynamic Flares (optional)
- Weapons Effects and Scoring
- Reports interference of point(s) on own-ship or other moving objects with predefined objects in the database
- Reports height of host-defined points or moving objects above terrain surface or above database features
- Reports range from viewpoint to specific database features in field of view
- Reports line-of-sight range between points in database, 360 degrees
- Electro-Optical, FLIR, NVG
- Variable from 7.5 to 60 Hz. update / 60 HZ. refresh rate
- 100 msec. at 30 Hz. update / 60 Hz. refresh
- Expandable to over 3M pixels at 30 Hz. update
- Raster, non-interlaced or 2:1 interlaced
- Software programmable/switchable, Genlock capable
- Non-Linear Image Mapping (NLIM) hardware standard
- Wide dynamic range to drive advanced displays
- Compatible with dynamic NLIM option
- Compatible with FOVs greater than 180 degrees
- No capacity or performance compromise
- Dynamic linear off-axis correction available
- Internal VME 68K-based
- Ethernet and HSD interfaces available

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